IMPLICATIONS OF VIKING COLOR DATA FOR EVOLUTION OF THE AMENTHES REGION, MARS

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In the eastern hemisphere of Mars, where the hemispheric dichotomy is not overlain by relatively recent flows from the Tharsis volcanoes, the Mars cratered terrain boundary (CTB) now exists as highly fractured terrain juxtaposed with the smooth plains of the northern hemisphere. Based on Mariner 9 topopgraphy, the southern cratered terrain in the Amenthes region (0-30°N, 225-270°W) is approximately 3-4 km above the northern plains, and the transition zone is marked by both broad plateaus and knobby terrain. In the Amenthes Southeast quadrangle, in particular, the continuum between large detached plateaus, smaller smooth topped plateaus and knobby hills can be seen. Knobby terrain, though, is not restricted to areas adjacent to the boundary, and extends some 1000 km to the north where isolated knobs can be mapped. To define the previous position and evolution of the boundary, the distribution of cratered terrain, characteristic landforms (knobby terrain and detached plateaus) have been mapped (1), as well as structural features across the boundary. Structural mapping (2) has indicated that the few graben that are present are oriented parallel to the boundary in the eastern hemisphere, and the the orientation of elongate knobs and detached plateaus also are parallel to the CTB. These results imply that the evolution of the CTB has involved normal faulting through extension perpendicular to the boundary.

If the knobby terrain is truly remnant of the ancient cratered terrain, then the far northerly occurrence of the knobs implies that at least part of the northern plains may be underlain by ancient terrain. In order to look at possible compositional variations to test this hypothesis, we have investigated the global color set compiled by the mars consortium (3). The application of this data to geologic interpretation of the boundary has been initially confined to the Amenthes quadrangle in an attempt to limit the numerous problems inherent in the data. Limitations of the Viking II approach color have been enumerated in (4), and include 1) time - the data is a "snapshot" of the northern hemisphere summer, 2) condensates - found to be a major subset of units defined in (4), 3) aeolian blanketing - subdues bedrock (?) reflectance, 4) redundancy in filter bandwidths, and 5) mixing of surface compositions without adequate ground truth. The two most serious problems for the present study are atmospheric contributions that increase with latitude, and the high correlation among the three color bands. Previous attempts to reduce the correlation among the three colors (red = .59 $\pm$ .05 microns, green = .53 $\pm$ .05 and violet = .45 $\pm$ .03) used ratios of the data and included albedo and thermal inertia (5). In that study, covariance among the three color ratios remained high, and most of the color variations were expressed by the red/violet ratio, consistent with (4).

To characterize units in the Amenthes quadrangle previously defined on the basis of high spatial resolution photogeologic mapping, the three

colors of the Viking II approach data were used at the original (1/4 degree) resolution. The data for this quadrangle do not differ significantly from the entire data set in that all three colors are highlycorrelated. As is true for areas studied in (4) and (5), most of the variance in the original Mars data set is carried by the red and violet channels. Reduction of the correlation among the three colores was done by a principal components analysis (see (5) for description). The three eigenvectors for the original data indicate that the first component is controlled equally by the three color channels, and accounts for 94% of the variance in the original data. The second component is controlled by the red and violet channels (4.86% of the variance), and the third by the green (1.11% of the variance). Before transformation of the data back to color space, the principal component images were normalized. The resulting data set showed correlation values of 0.50 (red to green), 0.26 (violet to red) and 0.88 (violet to green).

The decorrelated image data (in which reflectance values differ from the original data) were then subjected to an unsupervised classification, starting with the maximum number of data clusters present (n= 19), and interactively reducing the number by comparison of classified image with the geologic mapping results. The final classification resulted in definition of 13 units, 4 of which were related to atmospheric variations north of 10 - 15° N. In the southern part of the quadrangle, the classified units show areas of possible mixing (the "checkerboard-type" of (4) and (6)) between cratered terrain and smooth plains. Despite the problems inherent in the color data, some geologically meaningful correlations between surface units and the decorrelated color data suggest that in the Amenthes region, knobby terrain protruding through the plains units may be remnants of ancient cratered terrain extending northward beneath the more youthful smooth plains.

Using higher resolution individual Viking frames, we have identified two spectral types of plateaus in the Amenthes-Aeolis regions. The morphologic characteristics of these plateaus do not differ, but spectrally, one group is similar to the cratered terrain, whereas the other is intermediate between the cratered terrain and smooth plains. Such compositional indications are being used to map the extent of scarp retreat of the CTB, and to infer its former position.

References:
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